A new species of Paratachardina Balachowsky (Hemiptera: Coccoidea: Kerriidae)
related to the lobate lac scale, P. pseudolobata Kondo & Gullan

Takumasa Kondo a,⁎, Penny J. Gullan b, Robert W. Pemberton c

a Corporación Colombiana de Investigación Agropecuaria (CORPOICA), Centro de Investigación Palmira, Calle 23, Carrera 37, Contiguo al Penal, Palmira, Valle del Cauca, Colombia
b Department of Entomology, University of California, One Shields Avenue, Davis, CA 95616-8584, USA
c Research collaborator, Invasive Plant Research Laboratory, USDA-Agricultural Research Service, 3225 College Ave, Ft. Lauderdale, FL 33314, USA

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ABSTRACT

A new species of lac insect, Paratachardina javanensis Kondo and Gullan, sp. nov. (Hemiptera: Coccoidea: Kerriidae), is described and illustrated from a collection on Myrica rubra Siebold and Zucc. (also called Morella rubra Lour., Myricaceae) in West Java, Indonesia. This lac insect species is most similar morphologically to the pestiferous lobate lac scale, Paratachardina pseudolobata Kondo and Gullan. A comparison of the two species and an updated taxonomic key to all named Paratachardina species are provided.

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Introduction

A recent review (Kondo and Gullan, 2007) of the lac insect genus Paratachardina Balachowsky (Hemiptera: Coccoidea: Kerriidae) recognised nine species from Australasia, China, the Philippines, India and Sri Lanka, and formally named and described the lobate lac scale as Paratachardina pseudolobata Kondo and Gullan. This pestiferous species is highly polyphagous and feeds on the smaller stems and branches of woody plants, which can die if heavily infested (Pemberton, 2003b; Howard et al., 2006, 2010; Hamon and Hodges, 2008). The lobate lac scale has been introduced to Florida in the southeastern USA, the Bahamas and Cuba, and Christmas Island in the Indian Ocean (Howard and Pemberton, 2003; Mestre et al., 2006; Kondo and Gullan, 2007; Schroer et al., 2008), and this pest is likely to spread further. Effective and host-specific biological control agents are required to reduce populations of the lobate lac scale in its introduced range (Pemberton, 2003b), but its native range has not yet been determined. Recent field research to locate the native range of P. pseudolobata has centred on Southeast Asia where this lac scale has been collected recently in Malaysia on a range of host-plant species (RWP, unpublished data).

During searches for the lobate lac scale, one of us (RWP) collected specimens of an undescribed Paratachardina species that closely resembles P. pseudolobata but exhibits several morphological differences. The new Paratachardina species was found on trees of the red bayberry (or Chinese strawberry tree), Myrica rubra Siebold and Zucc., now often treated as Morella rubra Lour. (Myricaceae) (Huguet et al., 2005; USDA Plants Database, 2010), growing in Kebun Raya Cibodas (the Cibodas Botanical Garden) at approximately 1400 m on the slopes of Mount Gede in the Cibodas subdistrict of West Java, Indonesia. Only two trees were infested—one heavily and the other more lightly—and this species was not found on any other host trees, despite two days of searching for lac insects at that locality. There were thousands of individuals in the infestation and they were parasitised heavily by several species of wasps (Hymenoptera: Aphelinidae and Encyrtidae) (Hayat et al., 2009, in press), suggesting that the scales were native to the area. A North American relative of this Javan lac insect’s host plant is Myrica cerifera L., now often treated as Morella cerifera (L.) Small, and known as the southern wax-myrtle (Bornstein, 1997; Huguet et al., 2005; USDA Plants Database, 2010), which is a highly susceptible host species to P. pseudolobata in Florida (Pemberton, 2003a).

In this paper, the new Paratachardina species from West Java is described, illustrated and compared to its congeners. This new species is more similar to P. pseudolobata, based on morphology of the adult female, than to any other species of Paratachardina. We provide a revised key to separate the adult females of all named species of Paratachardina.
Materials and methods
Specimens available for this study consisted of dry and slide-mounted museum specimens, as well as some recently collected material. Samples of the new species of Paratachardina were obtained by RWP as part of a biological control program for the lobe lac scale. Authors TK and PJG are responsible for the taxonomic work reported here. Ethanol preserved specimens were slide-mounted using the techniques of Williams and Granara de Willink (1992) except that xylene was used instead of clove oil, and specimens were examined under a compound microscope. In the descriptions, the body shape of the adult female is described both as unmounted and as mounted on a microscope slide. An “unmounted” adult female refers to the insect’s resinsous test, either alive or preserved dry or in ethanol. Body length and width of the adult female are measured in millimeters as mounted on the slide; other measurements are in microns. Length is measured from the apex of the head to the posterior end of the body. Width is measured as the greatest width. The length of each spiracle is the length of the spiracular apodeme plus the peritreme. Description of the adult female is based on multiple slide-mounted specimens. The collection data, the total number of slides and in parentheses the number of specimens, followed by the depository in parentheses, are given for the material studied. For the specimen listings, one slide with one adult female would be listed as “1 (1 adult female).” and two slides with a total of 85 first-instar nymphs (40 on one slide and 45 on the other) would be listed as “2 (85 first-instar nymphs).” Most slides have a single adult female specimen. Each drawing is a generalisation of several specimens and was prepared with the assistance of a camera lucida attached to an Olympus BX40 compound microscope.

The description format and the terms used to describe the lac insect follow those used by Kondo and Gullan (2007) and Gullan and Kondo (2005). For example, the different size classes of microducts observed are divided into large-sized, medium-sized and small-sized microducts based on the relative size of the microduct rim on the cuticular surface. The small-sized microducts (ssm) are the most abundant microducts and are usually present dorsally and ventrally, and particularly around the body margin and submargins. Ventral duct clusters (vdc) are usually composed of medium-sized microducts (msm) only, and large-sized microducts (lsm) are found in the marginal duct clusters mixed with medium-sized microducts. The formula for the types and numbers of microducts in each marginal duct cluster (mdc) is specified by the total number of medium-sized microducts within each cluster, followed by the number of large-sized or medium-sized microducts in the outer margin of the cluster, followed by the number of large-sized microducts within the cluster, in their respective order. For example, “mdc-i: 30–60/6–11/6–19” refers to the most anterior marginal duct cluster (mdc-i) which has 30–60 medium-sized microducts, 6–11 large-sized microducts on its outer margin, and 6–19 large-sized microducts within the cluster.

The following material of P. pseudolobata was used to measure some structures that potentially differ from those in the new species; the TK numbers refer to DNA voucher specimens, most of which were used in the study by Schroer et al. (2008).


Abbreviations for the depositories are as follows: ANIC (the Australian National Insect Collection, CSIRO, Canberra, Australia), BME (the Bohart Museum of Entomology, Department of Entomology, University of California, Davis, California, U.S.A.), BMNH (The Natural History Museum, London), and USNM (National Museum of Natural History Coccoida Collection, Beltsville, Maryland, USA).

Taxonomy
Genus Paratachardina Balachowsky

Type species: Carteria decorella Maskell, 1893.

The genus Paratachardina was erected by Balachowsky (1950) for one Australian species, but subsequent authors added further species and the adult females of eight of the nine known species were described or redescribed and illustrated recently by Kondo and Gullan (2007). The description below of the new species from West Java brings the total number of species in the genus to 10.

Revised key to species of Paratachardina Balachowsky based on adult females
(Adapted from Kondo and Gullan (2007)).

1. Each brachial plate with about 200 pseudospines, occupying most of plate. Legs vestigial, each composed of a membranous tubercle-like area with a sclerotised claw........4 P. morobensis Williams and Watson

–Each brachial plate with fewer than 100 pseudospines, not occupying most of plate. Legs usually absent or, if present, vestigial, represented by a sclerotised claw or small sclerotised plate, not attached to a membranous tubercle-like area..................2

2. Antennae 4 segmented, each segment moderately sclerotised; brachial plates each an equilateral triangle; outer row of microducts of each marginal duct cluster composed of medium-sized microducts only..............................................P. decorella (Maskell)

–Antennae 2 or 3 segmented, each segment entirely membranous and delineated by a small sclerotised area; brachial plates variable, usually subcircular, oblong, or subquadrate; outer row of microducts of each marginal duct cluster either all composed of large-sized microducts or a combination of 2 size classes (lsm + msm), usually with at least some large-sized microducts. ...........................................3

3. Brachial plates each with 9–15 pseudospines; each brachial plate less than 60 μm (47–58 μm) long; large-sized microducts on outer row of most anterior marginal duct cluster (mdc-i) totalling 2..............................................P. minutus (Morrison)

–Brachial plates each with 17–60 pseudospines (usually more than 20); each brachial plate more than 60 μm (usually 70–120 μm) long; large-sized microducts on outer row of anterior marginal duct cluster (mdc-i) generally totalling 6–16..........................4
4. Body with 4 distinct lobes, even if anterior lobes smaller, with a clear indentation or constriction anteriorly on head. With a ventral duct cluster (vdc-1) close to mouthparts on each side................6
   –Body trilobate to broadly pear-shaped, with a round contour on head. Without a ventral duct cluster close to mouthparts on each side (i.e., vdc-2 closer to mdc-ii or mdc-iii).........................8
5. Ventral duct clusters totalling 4 pairs; pair of ventral duct cluster 1 (vdc-1) divided into 2 distinct clusters, distance between these 2 clusters equal to or greater than width of tentorial bridge........6
   –Ventral duct clusters totalling 5–7 pairs; pair of ventral duct clusters 1 (vdc-1) merging or almost touching, distance between these 2 clusters shorter than width of tentorial bridge..............7
6. Ratio of length to width of canella of anterior spiracle 2.3–8.0 (mostly >2.5); large-sized microducts on outer row of each of first four pairs of marginal duct clusters numbering: 11–19 in mdc-i, 4–7 in mdc-ii, 3–6 in mdc-iii and 3–4 in mdc-iv; ventral duct clusters 3 and 4 (vdc-3 and vdc-4) often merging..................P. javanensis Kondo and Gullan, sp. nov.
   –Ratio of length to width of canella of anterior spiracle 1.0–3.0 (mostly <2.3); large-sized microducts on outer row of each of first four pairs of marginal duct clusters numbering: 6–13 in mdc-i, 2–4 in mdc-ii, 2–4 in mdc-iii and 2–4 in mdc-iv; ventral duct clusters 3 and 4 (vdc-3 and vdc-4) distinct and usually separated by a distance almost as great as width of a duct cluster...............P. pseudolobata Kondo and Gullan
7. Pair of ventral duct cluster 1 (vdc-1) with 24–40 microducts combined; lac test orange, or wine red to dark reddish brown with tinges of orange..........................P. silvestri Mahdihassan
   –Pair of ventral duct cluster 1 (vdc-1) with 49–80 microducts combined; lac test purplish red to dark brown in colour, without tinges of orange....................................P. mahdihassani Kondo and Gullan
8. Pygidial apodemes well-developed. Second ventral duct cluster (vdc-2) close to second marginal duct cluster of mdc-ii)...............P. ternata (Chamberlin)
   –Pygidial apodemes absent. Second ventral duct cluster (vdc-2) close to third marginal duct cluster of mdc-iii)..............P. mithila Varshney/P. theae (Green)

Paratachardina javanensis Kondo and Gullan, sp. nov. (Fig. 1–3)

Types. Holotype: INDONESIA: West Java, Cibodas, coll. 26.vi.2007, R.W. Pemberton and H. Liu, ex Myrica rubra, 1 (1 adult female) (BME); dimensions for holotype: 1.82 mm long, 1.55 mm wide anteriorly, and ca 1.95 mm wide posteriorly. Paratypes: Same collection data as holotype, 3 (3 adult females) and 1 (ca 65 first-instar nymphs) (ANIC), 18 (18 adult females, including DNA vouchers TK0567 and TK0568) and 2 (ca 85 first-instar nymphs) (BME); 2 (2 adult females) (BMNH), 10 (10 adult females) and 2 (ca 85 first-instar nymphs) (USNM); same collection data as holotype except, coll. 12.ix.2007, P.T. Exindo, 6 (7 adult females) (BME).

Adult female

Unmounted material

Lac test purplish to brown, often with tinges of light brown. Test with 4 lobes, anterior pair of lobes each with 0–3 ridges, posterior pair of lobes each with 0–3 ridges, anterior pair of lobes much narrower than posterior pair; first-instar test incorporated into test on middorsum, area around first-instar test often lighter in colour; with a circular opening on an elevated area just posterior to first-instar test. Dimensions of adult female test: 1.1–2.2 mm long, 0.7–1.7 mm wide at anterior lobes, 1.4–2.2 mm wide at posterior lobes, 1.4–2.0 mm high. Lac texture granulose, very hard and brittle (Fig. 1).

Mounted material (n = 41, measurements and counts based on 30 specimens)

Body outline 4-lobed with anterior lobes less pronounced than posterior lobes, anterior margin narrower than posterior margin. Body 1.15–1.95 mm long, 0.9–1.8 mm wide anteriorly, 1.30–2.30 mm wide posteriorly at widest point (Fig. 2).

Dorsum. Brachia (br) short, 15–50 μm long, membranous, becoming slightly sclerotised at maturity. Brachial plates (brpl) subcircular, oblong, or subquadrat, each 75–90 μm long, 50–63 μm wide; brachial craters absent, with a group of 15–21 pseudospines (ps) on narrowest west of plate, each pseudospine 6–12 μm long, with 1 seta on each side of group of pseudospines, often with an additional seta at narrowest west of plate, each seta 4–10 μm long, setae often absent on one side. Brachial pores (hp) each ca 4–5 μm wide, with 4 or 5 (mostly 5) loculi, totalling 3–7 pores per plate, usually present on area just anterior to pseudospines, often 1–3 pores found within pseudospine group around its margin. Anterior spiracles (anfsp) each 55–68 μm long, peritremes 25–28 μm wide, surrounded by a sclerotised area 90–120 μm long, 40–60 μm wide, bearing 4–7 spiracular pores; canellae represented by a linear group of 10–20 pores, forming a narrow cluster 50–120 μm long and 10–30 μm wide, immediately outside and medial to spiracular sclerotisation; spiracular and canellar pores (cand) each 4–5 μm wide with 4 or 5 (mostly 5) loculi. Dorsal spine (dsp) well developed, 80–100 μm long, 63–93 μm at base, with a slit-like opening at apex; membranous pedicel either very short or absent, only slightly wider than base of dorsal spine. Anal tubercle (at) well

![Image A](imageA.jpg)

![Image B](imageB.jpg)

Fig. 1. An individual test, or scale cover, of an adult female of each of: (A) Paratachardina javanensis Kondo and Gullan, sp. nov., and (B) Paratachardina pseudolobata Kondo & Gullan.
developed, tapering, highly sclerotised; pre-anal plate (papl) 53–85 μm long, 155–170 μm wide, slightly less sclerotised than supra-anal plate (spanpl), each with a striated appearance; supra-anal plate 100–110 μm long, 115–125 μm wide, with a granulose texture on mid areas. Pygidial apodemes (pa) slightly to moderately developed, extending from base of each anal tubercle towards body apex. Anal fringe entire, composed of 4 plates; each anal fringe plate 32–57 μm long, 17–22 μm wide, middle plates shorter than lateral plates. Anal ring (ar) entire, 30–38 μm wide, tips of setae surpassing anal fringe. Microducts (ssm) scarce, present marginally...
and submarginally, with 7–13 ducts present on each antero-anal lobe; diameter of duct rim ca. 3 μm. Spermatoid ducts (spd) hard to detect, 1 or 2 associated with each microduct. Dorsal setae (dsset) each 5–8 μm long marginally and submarginally, with longer setae, each 12–16 μm long, in line running from laterad of anal tubercle to posterior body apex on each side.

Venter. Antennae (ant) located near margins about level of mouthparts, between mdc-ii and mdc-iii; each antenna 114–150 μm long, 2 segmented, segmentation poorly defined, with a sclerotised area near middle, with 2 longer setae and 2 or 3 shorter setae on sclerotised area at apex of terminal segment. Clypeolabral shield 140–150 μm long, 90–105 μm wide. Labium apparently 1 segmented, 45–65 μm long, 43–60 μm wide. Pre-oral lobes (prol) elongate, present along margins of clypeolabral shield on each side. Post-oral lobes (pool) each 38–55 μm wide, dome shaped, with microtrichia. Legs completely absent. Posterior spiracles (ssp) much smaller than anterior spiracles, each 40–43 μm long, spiracular peritreme 15–16 μm wide, with 7–11 spiracular pores (sp) present around each spiracle, each 3.0–4.0 μm wide. Marginal duct clusters (mdc) distinct, oval to elongate oval, 8 pairs in total; each composed of 2 types of microducts: (i) medium-sized microducts (msm) with elongate oval rim, each ca. 4.0 μm wide, most abundant type in each marginal duct cluster, and (ii) large-sized microducts (lsm) with subcircular rim, each ca. 5.0 μm wide, present on outer rim of cluster closest to body margin and on inner side of each cluster. Formula for marginal duct clusters as follows: mdc-i: 56–72/11–19/15–20; mdc-ii: 10–16/4.7–7/3–7; mdc-iii: 10–13/3–6/3–6; mdc-iv: 8–14/3–4/3–5; mdc-v: 22–26/4–7/5–9; mdc-vi: 30–43/5–8/8–10; mdc-vii: 38–46/7–9/10–13, and mdc-viii: 16–25/5–8/5–9. Ventral duct clusters (vdc) subcircular or irregular in shape, all composed of medium-sized microducts (msm), 4 pairs in total; pair just anterior to mouthparts (vdc-1) largest with each cluster of pair separated by at least width of tentorial bridge; second cluster (vdc-2) situated just lateral to mouthparts; third and fourth ventral duct clusters present submedially on posterior abdominal segments, with vdc-3 and vdc-4 of each side of body touching or almost so. Formula for each ventral duct cluster as follows: vdc-1: 21–42 microducts (50–80 combined); vdc-2: 9–15; vdc-3: 6–15; vdc-4: 8–15. Microducts (ssm) outside ventral and marginal duct clusters smallest, each with rim ca. 3.0 μm wide, present marginally and submarginally, abundant particularly around marginal duct clusters, rest of ventral derm devoid of microducts. Spermatoid ducts hard to detect, similar to those on dorsum, present around body margin, 1 or 2 associated with each microduct, appearing most numerous within each marginal duct cluster (distribution not illustrated). Ventral setae (vset) each 5–10 μm long, about 6 to 8 present anterior to mouthparts, 2–5 present anterolateral to each pre-oral lobe, a group of 3–5 setae behind each posterior spiracle, a pair on last 3 abdominal segments anterior to vulva (v), 1 or 2 pairs on segment posterior to vulva, and a few setae on submargin of posterior apex, setae absent elsewhere.

**Diagnosis.** Morphologically, the adult female of *P. javanensis* is very close to that of *P. pseudolobata*, with both having well-separated ventral duct clusters 1 (vdc-1) and a reduced number of ventral duct clusters, with a total of 4 clusters on each side of the body. However, the two can be separated readily by a number of features (Table 1), especially the shape of the canella of the anterior spiracles, which is much more elongate in *P. javanensis* (ratio of length to width mostly >2.5) than in *P. pseudolobata* (ratio of length to width mostly <2.3), and by the generally larger number of large-sized microducts in the outer row of all marginal duct clusters in *P. javanensis*. The numbers of microducts in the ventral duct clusters are also generally higher in ventral duct clusters 2–4 (vdc-2, vdc-3 and vdc-4) in *P. javanensis* (Table 1; see also taxonomic key). Even though the adult females of *P. javanensis* that we scored have slightly larger bodies, on average, than those of *P. pseudolobata*, the meristic differences reported above do not appear to correlate with body size of the adult females as some specimens of *P. pseudolobata*, especially those from Florida, have body lengths similar to or greater than some specimens of *P. javanensis* and yet the females of *P. pseudolobata* always have fewer ducts in the clusters. Furthermore, the test of *P. javanensis* has generally narrower anterior lobes and has tinges of light brown (anterior lobes not as narrow and with no tinges of light brown in *P. pseudolobata*) (Fig. 1). On the live or alcohol-preserved adult female of *P. javanensis* there is a more defined V-shaped marginal constriction between the anterior and the larger posterior body lobe than in *P. pseudolobata*, especially on more mature specimens (Fig. 3).

**Morphological variation.** On one adult female of *P. javanensis*, the distance between the two most anterior ventral duct cluster appeared to be shortened by the presence of a few microducts between the paired clusters, thus appearing similar to the Indian species, *P. mahdihassani* and *P. silvestri*, but it should not be mistaken with these two species because *P. javanensis* has 4 pairs of ventral duct clusters only (5–7 pairs in *P. mahdihassani* and *P. silvestri*). There is some variation among specimens in the number of ducts in each ventral and marginal duct cluster and the number of pores in the canella, but such variation is typical for *Paratachardina* species. Thus no significant

**Table 1**

Comparison of body sizes and diagnostic features of the adult females of *Paratachardina javanensis* Kondo and Gullan, sp. nov., and *P. pseudolobata* Kondo and Gullan; values are ranges based on 30 specimens of each species; abbreviations for structures are explained in the Materials and methods and in the description.

<table>
<thead>
<tr>
<th></th>
<th><em>P. javanensis</em></th>
<th><em>P. pseudolobata</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum body length (mm)</td>
<td>1.15–1.95</td>
<td>1.05–1.60</td>
</tr>
<tr>
<td>Maximum body width (mm)</td>
<td>1.30–2.30</td>
<td>0.85–1.60</td>
</tr>
<tr>
<td>Number of microducts in vdc-1</td>
<td>21–40</td>
<td>20–45</td>
</tr>
<tr>
<td>Number of microducts in vdc-2</td>
<td>9–15</td>
<td>3–11</td>
</tr>
<tr>
<td>Number of microducts in vdc-3</td>
<td>6–13</td>
<td>3–15</td>
</tr>
<tr>
<td>Number of microducts in vdc-4</td>
<td>8–15</td>
<td>2–12</td>
</tr>
<tr>
<td>Configuration of vdc-3 and vdc-4</td>
<td>Usually merging</td>
<td>Usually separated</td>
</tr>
<tr>
<td>Number of outer lsm in mdc-i</td>
<td>11–19</td>
<td>6–13</td>
</tr>
<tr>
<td>Number of outer lsm in mdc-ii</td>
<td>4–7</td>
<td>2–4</td>
</tr>
<tr>
<td>Number of outer lsm in mdc-iii</td>
<td>3–6</td>
<td>2–4</td>
</tr>
<tr>
<td>Number of outer lsm in mdc-iv</td>
<td>3–4</td>
<td>2–4</td>
</tr>
<tr>
<td>Number of pores in canella</td>
<td>10–20</td>
<td>9–19</td>
</tr>
<tr>
<td>Length of canella (μm)</td>
<td>50–120</td>
<td>25–80</td>
</tr>
<tr>
<td>Maximum width of canella (μm)</td>
<td>10–30</td>
<td>15–55</td>
</tr>
<tr>
<td>Ratio of length to width of canella</td>
<td>2.3–8.0 (mostly &gt;2.5)</td>
<td>1.0–3.0 (mostly &gt;2.3)</td>
</tr>
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**Fig. 3.** Body shapes of immature and mature adult females: *P. pseudolobata* Kondo and Gullan: (A) immature and (B) mature; *P. javanensis* sp. nov.: (C) immature and (D) mature.
morphological variation was found within *P. javanensis*, but all specimens were collected from just one locality.

**Etymology.** This species is named after its place of collection, i.e., Java.

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